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PATENT
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re application of:

CHATTERJEE

Application No.: 10/010,674

Filed: November 30, 2001

For: SYSTEMS AND METHODS FOR
EFFICIENT QUANTIZATION

Art Unit:

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-referenced application, please enter the following amendments and remarks.

IN THE SPECIFICATION:

On page 4, please delete paragraph beginning at line 29, and substitute therefor:

FIG. 5 is a simplified flow diagram illustrating one technique for generating an approximation of an integer division;

On page 4, please delete paragraph beginning at line 31, and substitute therefor:

FIG. 6 is a simplified flow diagram illustrating a method for performing an accurate integer division according to one embodiment of the present invention;

On page 5, please delete paragraph beginning at line 5, and substitute therefor:

FIG. 8 is a simplified flow diagram illustrating a method for performing an accurate integer division according to another embodiment of the present invention;

On page 12, please delete paragraph beginning at line 1, and substitute therefor:

Regarding Non-Intra quantization, in step 222, an intermediate value x is generated from the unquantized DCT coefficient $C[i]$ according to the same equation described with respect to step 202 of FIG. 4A. Then, in step 224, the value x is divided by the value $2*Q$. Finally, in step 226, the quantized coefficient $QC[i]$ is generated by clipping the value x generated in step 224.

On page 12, please delete paragraph beginning at line 14, and substitute therefore:

FIG. 5 is a simplified flow diagram of one embodiment of a method for computing an approximation of an integer division of an unsigned integer dividend X by an unsigned integer divisor D . This method is useful for applications, such as MPEG encoders and decoders, in which a divisor is known ahead of time (e.g., a constant), a divisor is known to be one of a relatively small number of possible divisors, in which a same divisor is used in many division operations, etc. For example, this method can be used for quantizing DCT coefficients using quantization step values and/or quantization scales.

On page 15, please delete paragraph beginning at line 4, and substitute therefor:

FIG. 7B is a simplified flow diagram of another embodiment of a method for determining a correction as in step 356 of FIG. 6. The method is similar to that

illustrated in FIG. 7A. However, in step 422, integer R' of word length n is computed according to the equation:

$$R' = ((2^n + k * (D / 2)) / D) * (2^n \% D) \quad (2)$$

where k is a number (typically an integer, but need not be) greater than or equal to zero that can be selected for the particular implementation. For instance, it has been determined that when k is one, the ranges of X and D over which an accurate result is produced are larger than when $k=0$. Particularly, it has been determined that accurate results are produced when X is within the range $[-2048, +2047]$ and when D is within the range $[1, 174]$. Additionally, it has been determined that when k is two, the ranges of X and D over which an accurate result is produced is further increased. Particularly, it has been determined that accurate results are produced when X is within the range $[-2048, +2047]$ and when D is within the range $[1, 32766]$. Note that when k is zero, equation (2) is the same as equation (1). The above embodiments may be accurate over other ranges of X and D as well, and such other ranges may be determined experimentally.

IN THE CLAIMS:

Please amend the following claims:

1 4. (Amended) The method of claim 2, wherein generating the correction
2 includes multiplying X by DR , wherein DR is $((2^n + k * (D / 2)) / D) * (2^n \% D)$, wherein k is
3 a non-negative number.

1 23. (Amended) The method of claim 21, wherein generating the
2 correction includes:
3 multiplying X'' by DR to produce a most significant word of $X'' * DR$
4 $(MSW(X'' * DR))$, wherein DR is $((2^n + k * (D / 2)) / D) * (2^n \% D)$, wherein k is a non-
5 negative number.

IN THE DRAWINGS:

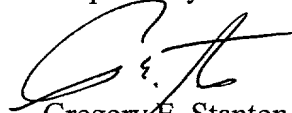
Twenty-two sheets of formal drawings are submitted by the response to the Notice to File Corrected Application Papers, filed concurrently herewith.

REMARKS

By this amendment, applicant has made of record handwritten, dated changes made by the inventor to the specification and claims of the application as filed. Entrance of the amendment is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,


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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

Page 4, paragraph beginning at line 29:

FIG. 5 is a simplified flow diagram illustrating one technique for generating an approximation of [a fixed-point] an integer division;

Page 4, paragraph beginning at line 31:

FIG. 6 is a simplified flow diagram illustrating a method for performing [a more accurate fixed-point] an accurate integer division according to one embodiment of the present invention;

Page 5, paragraph beginning at line 5:

FIG. 8 is a simplified flow diagram illustrating a method for performing [a more accurate fixed-point] an accurate integer division according to another embodiment of the present invention;

Page 12, paragraph beginning at line 1:

Regarding[,] Non-Intra quantization, in step 222, an intermediate value x is generated from the unquantized DCT coefficient $C[i]$ according to the same equation described with respect to step 202 of FIG. 4A. Then, in step 224, the value x is divided by the value $2*Q$. Finally, in step 226, the quantized coefficient $QC[i]$ is generated by clipping the value x generated in step 224.

Page 12, paragraph beginning at line 14:

FIG. 5 is a simplified flow diagram of one embodiment of a method for computing an approximation of an integer division of an unsigned integer dividend X by an unsigned [fixed point] integer divisor D . This method is useful for applications, such as MPEG encoders and decoders, in which a divisor is known ahead of time (e.g., a constant), a divisor is known to be one of a relatively small number of possible divisors,

in which a same divisor is used in many division operations, etc. For example, this method can be used for quantizing DCT coefficients using quantization step values and/or quantization scales.

Page 15, paragraph beginning at line 4:

FIG. 7B is a simplified flow diagram of another embodiment of a method for determining a correction as in step 356 of FIG. 6. The method is similar to that illustrated in FIG. 7A. However, in step 422, integer R' of word length n is computed according to the equation:

$$R' = ((2^n + k * (D / 2)) / D) * (2^n \% D) \quad (2)$$

where k is [some integer] a number (typically an integer, but need not be) greater than or equal to zero that can be selected for the particular implementation. For instance, it has been determined that when k is one, the ranges of X and D over which an accurate result is produced are larger than when k=0. Particularly, it has been determined that accurate results are produced when X is within the range [-2048, +2047] and when D is within the range [1, 174]. Additionally, it has been determined that when k is two, the ranges of X and D over which an accurate result is produced is further increased. Particularly, it has been determined that accurate results are produced when X is within the range [-2048, +2047] and when D is within the range [1, 32766]. Note that when k is zero, equation (2) is the same as equation (1). The above embodiments may be accurate over other ranges of X and D as well, and such other ranges may be determined experimentally.

In the claims:

1 4. (Amended) The method of claim 2, wherein generating the correction
2 includes multiplying X by DR, wherein DR is $((2^n + k*(D/2))/D)*(2^n \% D)$, wherein k is
3 a non-negative [integer] number.

1 23. (Amended) The method of claim 21, wherein generating the
2 correction includes:
3 multiplying X'' by DR to produce a most significant word of X''*DR
4 (MSW(X''*DR)), wherein DR is $((2^n + k*(D/2))/D)*(2^n \% D)$, wherein k is a non-
5 negative [integer] number.